Vermont Department of Education

Industrial Maintenance
(CIP: 47.0105)

Occupational Skills				
The Student demonstrates the specified level of competency in occupational skills:				
0	**1**	**2**	**3**	**4**
No Exposure	**Introduced**	**Practiced**	**Entry-level**	**Competency**

0 1 2 3 4

θθθθθ **A. Apply Safety Knowledge**
(Vermont Standards: 3.3, 7.18)

θθθθθ **B. Demonstrate Positive Work Attitude**
(Vermont Standards: 3.3, 3.10, 3.11, 3.14)

θθθθθ **C. Apply Basic Math and Measurement Skills**
(Vermont Standards: 7.6)

θθθθθ **D. Apply Blueprint Reading/Drawing Skills**
(Vermont Standards: 1.1, 1.2, 1.4, 5.29, 7.11)

θθθθθ **E. Use Common Hand Tools and Hand Power Tools in Benchwork**
(Vermont Standards: 7.6, 7.7, 7.12)

θθθθθ **F. Perform Preventive Maintenance on Building Equipment and Production Machinery**
(Vermont Standards: 7.11, 7.17, 7.18, 7.19)

θθθθθ **G. Apply Metals and Materials Knowledge**
(Vermont Standards: 7.11, 7.12)

θθθθθ **H. Perform Heat Treatment/Hardness Testing**
(Vermont Standards: 7.1, 7.12, 7.16)

θθθθθ **I. Apply Welding Safety Skills**
(Vermont Standards: 7.18)

θθθθθ **J. Apply Knowledge of Welding Metallurgy**
(Vermont Standards: 7.11, 7.12)

θθθθθ **K. Perform Oxy-fuel Welding and Cutting Tasks**
(Vermont Standards: 1.15, 1.22, 3.5, 3.10)

θθθθθ **L. Perform Shielded Metal Arc Welding/Gas Tasks**
(Vermont Standards: 1.15, 1.22, 3.5, 3.10, 7.18)

θθθθθ **M. Perform Tasks Using Fasteners**
(Vermont Standards: 1.21, 1.22, 7.11, 7.12)

θθθθθ **N. Use Coolants and Lubricants**
(Vermont Standards: 1.21, 1.22, 7.11, 7.12)

ELECTRICAL/ELECTRONIC/HVAC/PLUMBING SPECIALIZATION

θθθθθ **A. Apply Electrical and Electronic Systems Skills**
(Vermont Standards: 1.18, 1.20, 1.22, 7.7, 7.11, 7.18, 7.19)

θθθθθ **B. Apply Air Conditioning, Heating, and Ventilation Skills**
(Vermont Standards: 1.18, 1.20, 1.22, 7.7, 7.11, 7.18, 7.19)

θθθθθ **C. Apply Industrial Plumbing Skills**
(Vermont Standards: 1.18, 1.20, 1.22, 7.7, 7.11, 7.18, 7.19)

MACHINE TRADES SPECIALIZATION

θθθθθ **A. Apply Drill Press Skills**
(Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

θθθθθ **B. Apply Band Saw Skills**
(Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

θθθθθ **C. Apply Grinding Wheel Safety Procedures**
(Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

θθθθθ **D. Apply Pedestal/Bench Grinder Skills**
(Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

θθθθθ **E. Perform Lathe Operations**
(Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

θθθθθ **F. Perform Milling Operations**
(Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

θθθθθ **G. Perform Surface Grinding Operations**
(Vermont Standards: 3.7, 7.6, 7.10, 7.18, 7.19)

POWER MECHANICS SPECIALIZATION

θθθθθ **A. Perform Internal Combustion Engine (2-Cycle/4-Cycle) Tasks**
(Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

θθθθθ **B. Perform Lubrication System Tasks**
(Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

θθθθθ **C. Perform Cooling System Tasks**
(Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

θθθθθ **D. Perform Fuel System Tasks**
(Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

θθθθθ **E. Perform Ignition System Tasks**
(Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

θθθθθ **F. Perform Power Transmission Tasks**
(Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

θθθθθ **G. Perform Hydraulic System Tasks**
(Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19)

θθθθθ **H. Perform Heavy Equipment Operation Tasks**
(Vermont Standards: 1.22, 2.1, 2.3, 7.6, 7.10, 7.18, 7.19

DIRECTIONS

Evaluate the student by checking the appropriate box to indicate the degree of Competency. The rating for each task should reflect **employability readiness** rather than the grades given in class.

Rating Scale:

0 **No exposure**
1 **Introduced**- the student has been exposed through non participatory instruction (e.g. lecture, demonstration, field trip, video).
2 **Practiced**- the student can perform the task with direct supervision.
3 **Entry-Level Competency**- the student can perform the task with limited supervision and/or does not perform the task to standard (a typical entry-level performance expectation).
4 **Competency**- the student consistently performs task to standard with no supervision (on at least two occasions or at instructor's option).

INDUSTRIAL MECHANICS

GENERAL SKILLS

0 1 2 3 4

A. Apply Safety Knowledge

*A. 001 Define specific safety terms.

*A.002 Demonstrate the use of proper clothing, safety glasses, aprons, shields and other safety equipment.

*A.003 Know the importance of safety rules (horseplay hazards, misuse of equipment, …).

*A.004 Recognize any unsafe working conditions and practices, reporting them to supervisor.

*A.005 Maintain a clean, safe workstation.

*A.006 Demonstrate knowledge of proper hazardous waste handling and disposal procedures, in accordance with state and federal rules and regulations ("Right to Know" regulations, …).

*A.007 Demonstrate knowledge of proper shop emergency procedures (fire, illness, accident, basic first aid/CPR, … are desirable skills).

B. Demonstrate Positive Work Attitude

*B.001 Demonstrate growth as a safe, responsible, and disciplined worker.

*B.002 Communicate effectively both orally and in writing.

*B.003 Plan and perform work accurately, neatly and effectively.

*B.004 Demonstrate self-control and adaptability when some planned activity must be changed or fails.

*B.005 Demonstrate citizenship and ability to cooperate by working in a community service project.

C. Apply Basic Math and Measurement Skills

*C.001 Compute accurately using addition, subtraction, multiplication, and division processes (whole numbers, decimals, and fractions).

*C.002 Perform measurement tasks using metric and/or English systems.

*C.003 Convert measurement from the metric to the English system (and vice versa) with accuracy.

*C.004 Find and apply mathematical used in mechanical and electrical trades.

*C.005 Recognize units of linear, volume, weight, pressure, temperature, and angle measurement (metric and English).

*C.006 Select correct measurement device for the job.

*C.007 Demonstrate proper care and handling of measuring equipment.

*C.008 Differentiate between specifications and tolerances.

*C.009 Measure to specified tolerances using appropriate instruments and gauges used in the trades.

*C.010 Transfer measurement from print to physical part.

*C.011 Take part in a computer awareness program, including field trips.

D. Apply Blueprint Reading/Drawing Skills

*D.001 Define blueprint terminology: a) alphabet of lines, b) basic views, c) special views, and d) common abbreviations and symbols as per American Standards Association.

*D.002 Use prescribed methods of developing and dimensioning a working sketch.

*D.003 Complete visualization exercises.

*D.004 Define major geometric terms and apply geometric principles.

*D.005 Sketch various objects and locate hidden lines, surfaces, and projections.

*D.006 Visualize and draw three view problems/projections from views.

*D.007 Position multi-view drawings.

*D.008 Identify each type of pictorial drawing.

E. Use Common Hand Tools and Hand Power Tools in Benchwork

*E.001 Define hand tool, power hand tool, and benchwork terms.

*E.002 Identify common hand tools listed in appendix (lit developed by each Area Vocational Center).

*E.003 Demonstrate the safe use of hand tools and power hand tools to perform bench operations, selecting proper tool for job.

*E.004 Maintain and/or sharpen tools while following safety procedures.

F. Perform Preventive Maintenance on Building Equipment and Production Machinery

*F.001 Define preventive maintenance terminology.

*F.002 use proper electrical and hydraulic “lock out” while working on equipment and machinery.

*F.003 Demonstrate proper lubrication of equipment and machines to manufacturer’s specifications.

*F.004 Demonstrate proper adjustment of machines and equipment (e.g., troubleshoot simple maintenance problems).

*F.005 Demonstrate how to clean and paint equipment.

*F.006 Set up, level, and position machine and equipment.

G. Apply Metals and Materials Knowledge

*G.001 Define terminology of metals, alloys and materials.

*G.002 Identify ferrous and nonferrous materials.

*G.003 Select proper speeds and feeds for the machining of materials.

*G.004 Identify common plastic materials used in industry.

*G.005 Demonstrate knowledge of the compatibility of dissimilar metals.

*G.006 Demonstrate knowledge of metal gauge system.

*G.007 Demonstrate knowledge of common insulating materials used in industry.

*G.008 Select appropriate materials for specific applications.

*G.009 Compare and contrast metal identification systems.

H. Perform Heat Treatment/Hardness Testing

*H.001 Define heat treatment/hardness testing terminology.

*H.002 Perform treatment processes such as: hardening, tempering, annealing and casehardening.

*H.003 Identify various pieces of heat treatment equipment.

*H.004 Explain: steel manufacturer's heat treatment data and the effects of various heat treatment processes.

*H.005 Perform hardness testing with a file.

*H.006 Perform harness testing by spark (grinder).

*H.007 Perform harness testing machine procedures (Rockwill, Brinell, Scleroscope, …) on flat stock and round stock.

*H.008 Compare, contrast and convert values from one hardness testing method to another.

I. Apply Welding Safety Skills

*I.001 Dress properly to meet industry standard for safety.

*I.002 Control hazardous fume accumulation during welding.

*I.003 Demonstrate how to prevent fires and explosive situations in welding.

*I.004 Explain and demonstrate the safe usage of oxygen, Acetylene, Mapp and inert gases and their related equipment.

J. Apply Knowledge of Welding Metallurgy

*J.001 Demonstrate knowledge of the characteristics of ferrous metals and nonferrous metals.

*J.002 Demonstrate methods of identifying metals: a) spark test, b) oxy-fuel toch test, c) fracture test, d) color test, e) ringing or sound test, f) magnetic test, and g) chip test.

K. Perform Oxy-Fuel Welding and Cutting Tasks

*K.001 Set up the oxy-fuel welding equipment using all safety practices, performing leak test and correction procedures: a) soap and water, b) shutting off cylinders.

*K.002 Set up and test the oxy-fuel cutting equipment.

*K.003 Light and adjust the proper flame to oxy-fuel cut.

*K.004 Describe and practice each of the following oxy-fuel cutting processes: a) straight line cut, b) beveling, c) piercing and hole cutting, d) shape cutting, e) gouging, and f) cutting cast iron.

*K.005 Perform basic oxy-fuel welding procedures.

L. Perform Shielded Metal Arc Welding/Gas Tasks

*L.001 Identify SMAW power source and equipment.

*L.002 safely flat position weld to industry standards.

*L.003 Safely horizontal position weld fillets and grooves to industry standards.

*L.004 Safely vertical position weld fillets and grooves to industry standards.

*L.005 Safely set up the GTAW power supply and equipment in accordance with rules and regulations established by the welding industry.

*L.006 Safely start the arc and run a bead; weld in the flat position; weld out of position.

*L.007 Safely perform the following flat welds on aluminum, stainless steel, and mild steel: a) butt, b) lap, and c) tee.

*L.008 Safely perform the following out of position welds on aluminum, stainless steel and mild steel: a) butt, b) lap, and c) tee.

M. Perform Tasks Using Fasteners

*M.001 Identify permanent fastener types: a) pop rivet, b) steel/alum rivet, …

*M.002 Identify semi-permanent fastener types: a) bolts, b) screws, c) nails, d) clamps, e) keys, f) turnbuckles, g) clips, h) pins, I) nuts, j) heli-coils, …

*M.003 Identify and/or measure fasteners using thread types: a) USS/Metric, b) length/diameter, c) grading-hardness, d) UNF/UNC, e) head design, f) thread measurement, g) NPT, …

*M.004 Select the appropriate size tap, die, drill, and/or rod.

*M.005 Correctly “chase” old or damaged threads.

*M.006 Accurately and safely drill the required hole for tapping.

*M.007 Use correct counterbore and countersink processes.

*M.008 Demonstrate knowledge of various ways for organizing and staining fasteners.

*M.009 Demonstrate record keeping practices and costs.

N. Use Coolants and Lubricants

*N.001 Demonstrate knowledge of the various types of cutting oils and coolants, understanding their properties, viscosity, heat absorption capabilities, additives, and functions.

*N.002 Safely apply the correct cutting oil or coolant for a specific job.

*N.003 Demonstrate maintenance and cleaning procedures for cooling systems.

*N.004 Understand proper storage and disposal of coolants and lubricants.

*N.005 Understand application of lubricants for industrial and building equipment/machinery maintenance.

Electrical/Electronic/HVAC/Plumbing Specialization

0 1 2 3 4

A. Apply Electrical and Electronic Systems Skills

*A.001 Define electrical terminology and basic electronic terminology (including safety terms).

*A.002 Use proper safety equipment with electricity.

*A.003 Recognize any unsafe working conditions and report them to supervisor.

*A.004 Demonstrate familiarity with and use of NEC code book.

*A.005 Understand and apply basic electrical theory and terminology.

*A.006 Identify electrical schematic symbols.

*A.007 Identify AC and/or DC circuits.

*A.008 Determine circuit polarity.

*A.009 Use meters or other instruments to measure ohms, amps, and volts.

*A.010 Understand basic transformer theory.

*A.011 Safely test internal motor circuits.

*A.012 Understand basic alternator/generator theory.

*A.013 Measure generator or alternator outputs.

*A.014 Identify components of the internal layout of electrical service panels.

*A.015 Select the correctly rated wiring materials for the job.

*A.016 Understand and apply basic electronic instrumentation and control theory.

B. Apply Air Conditioning, Heating, and Ventilation Skills

*B.001 Define air conditioning, heating, refrigeration, and ventilation terms.

*B.002 Identify the common environmental systems in use in buildings.

*B.003 Identify the basic components of hot water, steam, radiant, storage, and/or air heating systems (electric, oil fired, solar, …).

*B.004 Identify the basic components of an air conditioning system.

*B.005 Identify the basic components of a ventilation system.

*B.006 Identify and understand the application of basic sheet metal tools, machines, and equipment.

*B.007 Safely operate basic sheet metal tools, machines, and equipment.

*B.008 Understand basic sheet metal lay out (locks, joints, …), selecting proper tools for specific jobs.

*B.009 Understand the basic principles of airflow, balancing , and distribution.

*B.010 Read and understand HVAC blueprints.

*B.011 Understand basic elements of heat gain and heat loss.

*B.012 Identify and understand the application of HVAC control systems.

*B.013 Participate in a field trip to view a “state of the art” HVAC system.

*B.014 Demonstrate knowledge of basic energy conservation techniques and equipment.

*B.015 Describe the operation of a heat pump.

C. Apply Industrial Plumbing Skills

*C.001 Identify the most common types of pipe.

*C.002 Be able to measure pipe and tubing accurately.

*C.003 Describe the type of suitable application for each type of pipe.

*C.004 Select the appropriate type and size of pipe or tubing for a specific job.

*C.005 Identify shut-off/gate valves, pressure regulating controls, and solenoid operated controls.

*C.006 Identify the standard types of fittings for pipe and/or tubing applications.

*C.007 Identify the tools associated with iron pipe threading.

*C.008 Safely thread and assemble ion pipes.

*C.009 Safely clean, flux, heat and solder copper pipe and tubing.

*C.010 Safely clean and glue PVC pipes.

*C.011 Safely bend, fit, flare and connect copper and steel tubing.

*C.012 Identify piston, centrifugal, and submersible pumps.

*C.013 Identify and describe operation of pressure cutoff switches and air volume controls.

*C.014 Identify types of water pressure storage systems.

*C.015 Describe the importance of filters and chemical treatment systems.

*C.016 Read and interpret construction piping blueprints.

*C.017 Identify and understand basic piping system design considerations (e.g., support systems, venting, pressure changes, pipe sizing, …).

*C.018 Understand the applications and safety considerations of pipe insulation (e.g., asbestos, foam, …).

Machine Trades Specialization

A. Apply Drill Press Skills

*A.001 Define drill press skills.

*A.002 Safely perform drill press operations (drilling, tapping, reaming, counterboring, countersinking, spotfacing, and machine finishing, …).

*A.003 Select and set speeds and feeds for specific jobs.

*A.004 Demonstrate proper use of machinist's handbook.

*A.005 Lay out center punch and drill to 1/64".

*A.006 Safely sharpen a drill bit.

B. Apply Band Saw Skills

*B.001 Define band saw terminology.

*B.002 Safely perform basic machine maintenance and adjustments.

*B.003 Demonstrate knowledge of types of blades, tooth formation, pitch, gauge width, set and hardness.

*B.004 Identify material to be cut and set proper cutting speed.

*B.005 Safely use horizontal cutoff saw including gang clamping, blade changing, and gauge setting (within 1/16" line) to job specifications.

*B.006 Safely demonstrate proper blade welding procedures.

C. Apply Grinding Wheel Safety Procedures

*C.001 Safely ring test wheel.

*C.002 Safely balance grinding wheel.

*C.003 Safely mount and dress a grinding wheel.

*C.004 Correctly adjust work rests and guards.

*C.005 Safely mount (being aware of RPM specifications) and dress a grinding wheel.

D. Apply Pedestal/Bench Grinder Skills

*D.001 Define pedestal/bench grinder terminology.

*D.002 Safely grind hand and cutting tools.

E. Perform Lathe Operations

*E.001 Define lathe terminology.

*E.002 Identify the major components of the lathe and explain their functions.

*E.003 Identify specific single-point cutting tool and explain their use.

*E.004 Demonstrate the procedures for safely cleaning, lubricating, and maintaining a lathe.

*E.005 Safely demonstrate single-point cutting for tool sharpening.

*E.006 Safely perform basic lathe operations (facing, straight-turning, shouldering, tabor turning, boring, cut off, …).

*E.007 Demonstrate knowledge of speeds and feeds for carbide tooling.

F. Perform Milling Operations

*F.001 Define milling terminology.

*F.002 Safely perform basic milling machine maintenance.

*F.003 Safely perform basic milling machine set-ups.

*F.004 Safely perform basic operations (slab, slop, face, straddle, …).

*F.005 Select and safely install cutters.

*F.006 Select speeds and feeds.

*F.007 Select work holding devices.

*F.008 Safely mill product to specified tolerances.

*F.009 Select mount (rotary table dividing head).

G. Perform Surface Grinding Operations

*G.001 Define surface grinding terminology.

*G.002 Safely perform basic grinding operations (plunge grinding, angular grinding, cut off grinding, cutter grinding, shoulder grinding, flat grinding, …).

*G.003 Select a wheel with correct grain, structure, and bond for a specific job.

*G.004 Select feed rates for specific jobs.

*G.005 Identify and safely use accessories (toolmaker’s vise, sine bars, …).

A. Perform Internal Combustion Engine (2-Cycle/4-Cycle) Tasks

*A.001 Explain Internal Combustion Engine (2-Cycle/4-Cycle) Tasks.

*A.002 Disassemble two-cycle and four-cycle engines, naming the parts and their functions.

*A.003 Measure engine parts to check specifications and tolerances.

*A.004 Reassemble and safely test-run two-cycle and four-cycle engines.

B. Perform Lubrication System Tasks

*B.001 Identify lubricants and demonstrate a knowledge of types and grades.

*B.002 Safely use lubricants, according to manufacturers' recommended maintenance procedures and service intervals.

C. Perform Cooling System Tasks

*C.001 Identify specific types of cooling systems and components.

*C.002 Inspect, test, service, and repair cooling systems to manufacturer's specifications, exercising safety procedures.

D. Perform Fuel System Tasks

*D.001 Demonstrate knowledge of basic theory of fuel/air mixture in fuel systems (diesel, gasoline…).

*D.002 Identify specific methods of fuel/air delivery in a fuel system (turbo charger/natural aspiration/fuel injection).

*D.003 Inspect, service, and repair fuel systems to manufacturer's specifications while following safety procedures.

E. Perform Ignition System Tasks

*E.001 Demonstrate knowledge of ignition system theory (conventional and electronic).

*E.002 Demonstrate knowledge of the relationship of ignition system components (e.g., coil, condenser, wiring, distributor, spark plugs, contact module, sensor, resistors, spark contact mechanisms, magnetos, glo plugs, …).

*E.003 Test, repair, and replace components of ignition systems to manufacturers' specifications while following safety procedures.

F. Perform Power Transmission Tasks

*F.001 Demonstrate knowledge of safety procedures for the maintenance of power trains.

*F.002 Identify components of a basic clutch system and their relationship to each other.

*F.003 Identify drives in the following categories: belt, gear, chain, shaft, hydraulic, and one-way roller clutches.

*F.004 Safely remove, disassemble, clean, lubricate, and re-assemble bearings.

*F.005 Identify the types of bearings found in power transmission systems (e.g., sleeve, roller, ball, needle, pillow block support, flange, …).

*F.006 Describe the proper lubrication procedures for each type of bearing.

*F.007 Describe the difference between sprocket and gear drive.

*F.008 Demonstrate knowledge of the concepts applying to gear and sprocket tooth design (e.g., pitch, number of teeth, gear ratio, backlash, mech, …).

*F.009 Safely lubricate gear and sprocket drive systems.

*F.010 Identify types of belts used in drive systems (e.g., flat belt, v belts, toothed belts, variable speed, …).

*F.011 Safely replace a worn belt, correctly sizing, aligning, and tensioning, to manufacturer's specifications.

*F.012 Determine the speed and direction of rotation for each gear in a drive system given the input speed, initial rotation, and gear ratios.

G. Perform Hydraulic System Tasks

*G.001 Demonstrate knowledge of hydraulic system maintenance safety procedures.

*G.002 Describe the basic principles of hydraulics.

*G.003 Define specific hydraulic system terms.

*G.004 Demonstrate basic knowledge of hydraulic system principles related to pressure, volume, and flow.

*G.005 Describe the various types of hydraulic pumps and their applications (gear pumps, vane pumps, pistons pumps, variable/fixed displacement pumps.

*G.006 Describe the various types of hydraulic valves and their applications (relief valves, pressure reducing valves, unloading valves, check valves, spool valves, electro-hydraulic valves, flow control valves, …).

*G.007 Demonstrate knowledge of the basic operating principles of cylinders in hydraulic systems.

*G.008 Identify the basic types of filters and seals used in hydraulic systems.

*G.009 Safely disassemble and re-assemble hydraulic systems to manufacturer's specifications.

*G.010 Describe the purpose accumulators of hydraulic systems.

*G.011 Safely perform the basic maintenance procedures of hydraulic systems including bleeding system, cleaning/flushing, leak prevention, pre-operation checks, ….

*G.012 Determine the proper size and ratings for reservoir and hoses of hydraulic systems.

H. Perform Heavy Equipment Operation Tasks

*H.001 Describe heavy equipment operation safety procedures for specific pieces of equipment.

*H.002 List the sequence of procedures for a general maintenance program for specific pieces of heavy equipment, according to manufacturer's specifications.

*H.003 Safely perform checklist procedures for equipment operation including: oil, water, battery, lights, fuel, safety shield, grease, air pressure, ….

*H.004 Demonstrate knowledge of heavy equipment instrumentation and components.

*H.005 Safely operate available pieces of heavy equipment.